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REMITTANCES AND ASSET ACCUMULATION IN BANGLADESH: A STUDY USING GENERALISED PROPENSITY SCORE

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Abstract: Drawing on a sample of households in Bangladesh, we utilise the generalised propensity score method to investigate the impact of internal and international remittances on households' net assets. The analysis suggests an inverted U-shaped relationship between the amount of internal remittances and the net assets of households. The effect of international remittances on net assets is similarly inverted U-shaped. The paper also indicates not only the source but also the size of remittances effects of the utilisation of remittances for asset accumulation. © 2019 The Authors Journal of International Development Published by John Wiley & Sons Ltd.

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1 INTRODUCTION

The importance of international migration and remittances to the economies of poor developing countries is well known to academics and policy makers. With respect to the economy of Bangladesh, the contribution of international remittances to the balance of payments of the country is well known. However, at the household level, the effects of remittances are less clear and understudied. For example, it is not known whether the effects of internal remittances (from other parts of the country) have the same effects as international remittances. Data from the Household Income and Expenditure Survey (HIES) of 2010, conducted by the Bangladesh Bureau of Statistics, demonstrate that about 12 per cent of Bangladeshi households received internal and about 9 per cent received international remittances (Chowdhury, 2015). Therefore, both internal and international

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remittances are important for Bangladeshi households. The recent academic and policy literature largely ignores the vital role played by internal remittances. This study aims to address this gap by analysing the effects of both internal and international remittances on the asset accumulation by Bangladeshi households using HIES 2010.

This study regards internal and international remittances as treatments and then evaluates the impact of these treatments on net assets of households. The propensity score matching (PSM) method developed by Rosenbaum and Rubin (1983) is regularly used for evaluating impacts of unit level treatments where the treatments take binary values of 0 and 1. The remittances data available via the HIES 2010 on the other hand are continuous. The generalised propensity score (GPS) method developed by Hirano and Imbens (2004) made possible the evaluation of the impact of continuous treatments. The availability of data coupled with the research question allowed us to utilise the GPS method for this research. Although a number of papers on remittances have evaluated the impact of binary treatments via the PSM, this paper is likely to be the first application of the GPS method to the remittances literature.

The paper addresses the hypothesis of the fungibility of remittances. If remittances are fungible, that is, if they are regarded as any other income by households, there should be no difference between the impacts of internal and international remittances. However, previous studies demonstrated evidence both for and against fungibility. In Bangladesh, it is commonly perceived that international remittances are used mainly in acquiring assets, but we have not found any empirical studies evidencing this.

An additional contribution of the study is its focus on a country in Asia. Many Asian countries including Bangladesh have significant positions in the global economy in terms of migration and remittances. As demonstrated in Table 1, nine of the top 15 countries for migration and seven of the top 15 countries for remittances are Asian. Table 1 also demonstrates Bangladesh as one of the leading countries in the world in terms of migration and remittances. Three South Asian countries (Bangladesh, India and Pakistan) are within

Table 1. Top 15 countries by migration and remittances

Migration		Remittances	
Top 15 countries in 2017	Estimates of migrant stocks (in million)	Top 15 countries by remittances inflows in 2016	Inflows (US$ million)
India	***16.44***	***India***	***62 744***
Mexico	11.88	***China***	***61 000***
Russian Federation	10.96	***Philippines***	***31 145***
China	***10.06***	Mexico	28 691
Bangladesh	***7.80***	France	24 373
Syrian Arab Republic	***7.78***	***Pakistan***	***19 761***
Pakistan	***6.10***	Nigeria	19 636
Ukraine	6.00	Germany	16 683
Philippines	***5.97***	Egypt, Arab Rep.	16 590
Afghanistan	***5.06***	***Bangladesh***	***13 544***
United Kingdom	4.82	***Vietnam***	***11 880***
Poland	4.29	Spain	10 281
Indonesia	***4.25***	Belgium	10 126
Germany	4.14	Italy	9537
Kazakhstan	***3.95***	***Indonesia***	***8891***

Countries marked by bold and italics are Asian countries.
Source: Data from World Bank (2018).

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the top 15 countries for both migration and remittances, while India is the leading country for both. Despite that the only representative of the Latin America is Mexico, the literature is dominated by studies on a handful of Latin American countries. This suggests that there is a great need for studies analysing the effects of remittances in Asian countries. This study contributes towards filling this gap.

Through the utilisation of GPS method, we aim to identify the relationship between remittances and net assets in Bangladeshi households. For internal remittances, we find an inverted U-shaped relation, which implies that for a higher amount of remittances, the asset accumulation falls. With respect to international remittances, we observe a similar relationship between remittances and assets, that is, the decline of asset accumulation as remittances increase. The results also indicate that the amount of remittances can be an influential factor for the accumulation of assets. This finding generates an important understanding on the utilisation of remittances in Bangladeshi households, which is in contrast to the popular belief (i.e. international remittances are used mainly for asset accumulation in Bangladesh). Subject to the availability of data, the findings can be easily compared by replicating the study for other Asian countries.

The remaining sections are as follows. Section 2 provides a brief review of literature on migration and remittances. Section 3 provides a brief description of the GPS method. Section 4 discusses data and descriptive statistics. Section 5 estimates the impact of internal and international remittances on assets using semi-parametric techniques. Section 6 runs further analysis using a parametric method. Section 7 discusses the results and concludes.

2 A LITERATURE REVIEW

The remittances literature looks at the effects of remittances on poverty, health, education, investment, labour force participation, economic growth etc. As the literature is large and growing (although Asian countries remain relatively under-represented), we do not attempt any comprehensive survey of the literature here, rather the readers are referred to surveys like Adams (2011), Yang (2011) and Sirkeci, Cohen, and Ratha (2012).

The focus of our study is the impacts of internal and international remittances on accumulation of assets in Bangladesh. Studies on evaluating the impact of remittances on asset accumulation in Asian country including Bangladesh is rather limited compared with the position of those countries depicted by Table 1. Adams (1998) is one of the first studies that looked at the impact of remittances on asset accumulation in Asia. This study looked at both internal and external remittances in rural Pakistan and found that external remittances have a positive and significant effect on land accumulation while internal remittances have a positive and significant effect on the accumulation of agricultural capital. Mansuri (2007) found that migration has a large positive effect on land purchase in Pakistan. Quisumbing and McNiven (2010) found that in the Philippines, internal remittances have a positive impact on housing, consumer durables, non-land assets however not on land assets. De and Ratha (2012) found that, in Sri Lanka, remittances contribute to an increase in human capital accumulation among children; however, they did not find any evidence of a significant increase of households' asset accumulation. Garip (2014) studied the effects of internal migration and remittances on wealth accumulation in rural Thailand and found equalising effects of migration, as rich households lose productive assets with migration while poor households gain productive assets. Utilising the PSM method, Ahmed, Mughal, and Klasen (2018b) studied the asset accumulation pattern in Pakistan and found that foreign

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remittances resulted in an increase in assets; however, productive assets did not change. The domestic remittances were found to have no effect on assets.

Among the studies analysing the effects of migration and remittances in Bangladesh is Mahmud and Osmani (1980) who investigated the relationship between overseas workers remittances, balance of payment, income and savings of households. Using the computable general equilibrium (CGE) modelling, Stahl and Habib (1989) demonstrated that remittances may increase the production of domestic consumption goods and intermediate products. Khan (2008) found positive impact of foreign remittances on poverty levels using Household Income and Expenditure Survey 2005 (HIES 2005) data. Using time series data over a 25-year period, Siddique, Selvanathan, and Selvanathan (2012) found positive effects of remittances on economic growth in Bangladesh. Khandker, Khalily, and Samad (2012) using the survey data of 480 918 households found that seasonal migration helped households to smooth consumption and that the probability of migration was higher in households with a high dependency ratio, a high dependency on wage employment and in villages with high unemployment. Chowdhury and Rabbi (2014) using annual data from 1971 to 2008 showed that influxes of workers' remittances significantly appreciates the real exchange rate and deteriorates the external trade competitiveness. Hatemi-J and Uddin (2014) found that poverty reduction and remittances in Bangladesh affect each other. Chowdhury (2015) utilised HIES 2010 data to associate households' characteristics with the mode of remittances in Bangladesh. Although the possibility of existence of other studies cannot be excluded, it appears that the amount of studies on migration and remittances in Bangladesh is rather limited relative to the position of Bangladesh in terms of migration and remittances in the world economy. The use of survey data in Bangladesh is rare, and to our knowledge, no study assessed the effects of remittances on households' assets or wealth in Bangladesh using the HIES data.

The present study applies the GPS method, which is a development of the PSM technique. We have found that a number of papers applied PSM to identify the impact of remittances. However, they do not necessarily look at an Asian country or the asset accumulation with an exception of Ahmed et al. (2018b) that utilised PSM to study the asset accumulation in Pakistan. For Bangladesh, Khan (2008) utilised PSM to find the impact of remittances on poverty levels. Among some other studies, Mueller and Shariff (2011) looked at the effects of internal remittances on schooling in India and found positive correlation between remittances and school attendance. Fransen and Mazzucato (2014) studied the effects of international remittances on post conflict urban Burundi and found evidence of strong effects on non-productive assets, such as living conditions and food security and weak effects on asset ownership. Ahmed, Mazhar, and Inmaculada (2018a) studied the consumption pattern of Pakistani migrants' households and found that both internal and international remittances are used for education and health care with no evidence of increase of frivolous consumption. We have not observed any study utilising the GPS method that considers remittances as continuous treatments. However, this method has been applied in several studies in relation to migration such as Egger, Von Ehrlich, and Nelson (2012) and Serrano-Domingo and Requena-Silvente (2013).

3 GENERALISED PROPENSITY SCORE

The GPS method has close association with the PSM technique developed by Rosenbaum and Rubin (1983). The general idea of PSM is that in field data or observational studies,

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comparable control and treatment groups are not available. Therefore, propensity scores, which are the probabilities of receiving treatments, are calculated for each unit. These scores serve as the basis for calculating effects of treatments on individual units. GPS develops PSM by using continuous treatment values instead of binary values. Suppose that there exists a potential set of outcomes $Y_i(t)$ where t is defined over an interval $T_i \in [t_0, t_1]$ whereas for binary treatment of PSM it is $T_i \in \{0, 1\}$. The potential outcomes are referred as dose–response functions, and the objective of the analysis is to estimate the average dose–response function $E[Y_i(t)]$ at particular levels of treatments.

Hirano and Imbens (2004) generalise the *unconfoundedness* assumption for binary treatments made by Rosenbaum and Rubin (1983) to the continuous case as

$$Y(t:) \perp T \mid x \text{ for all } cc; T_i \in \left[t_0, t_1\right] \tag{1}$$

It is referred as *weak unconfoundedness*, as it only requires conditional independence to hold for each values of the treatment, rather than joint independence of all potential outcomes. Assuming that the conditional density of the treatment given the covariates is given by $r(t,x) = \int_{T \mid x}(t|x)$, the GPS defined by Hirano and Imbens (2004) is

$$R = r(T, x) \tag{2}$$

The GPS has a balancing property similar to the balancing property of the propensity score. Within the strata with the same value of the $r(t, x)$, probability that $T = t$ does not depend on the value of x, that is, the GPS has the property that $x \perp 1\{T = t\} \mid r(t,x)$. In other words, when looking at two pairs with the same probability, their treatment levels are independent of observed covariates. The definition of GPS does not require unconfoundedness; however, in combination with unconfoundedness, it implies that the assignment of treatments is unconfounded given the GPS.

Hirano and Imbens (2004) stated that GPS can be used to eliminate any biases associated with differences in the covariates. The procedure consists of two steps. First is the estimation of the conditional expectation of the outcome as a function of two scalar variables, the treatment level *T*and *R*, that is,

$$\beta(t, r) = E[Y|T = t, R = r] \tag{3}$$

Second is the estimatation of the dose–response function at a particular level of the treatment by averaging this conditional expectation over the GPS at that particular level of the treatment.

$$\mu(t) = E[\beta(t, r)] \tag{4}$$

It is important to note that Equation (4) does not imply averaging over *R*, rather over the treatment level of interest.

GPS has a useful role in our present study because of possible selection bias problem as households that received lower amount of remittances can be different from the households that received higher amount of remittances (see Adams 2011). GPS provides a solution to this selection bias problem as Equation (3) specifies conditional output as a function of two variables only, that is, GPS and the treatment level.

Hirano and Imbens (2004) estimated dose–response functions using a parametric method. Bia, Flores, Flores-Lagunes, and Mattei (2014) developed a STATA routine in line

DOI: 10.1002/jid

with the semi-parametric method employed by Flores, Flores-Lagunes, Gonzalez, and Neumann (2012). Bia et al. (2014) first estimates GPS and then estimates dose–response functions using non-parametric techniques. The GPS is estimated employing a suitable functional form. Specifically

$$g(T_i|X_i)\tilde{}\psi(h(\gamma, X_i), \theta)$$

where g is a link function, ψ is a probability density function, h is a flexible function of covariates depending of unknown parameter vector γ and θ is scale parameter. The probability distributions allowed are normal, inverse Gaussian or Gamma distributions. The maximum likelihood model is used to fit the models. The common support is imposed by Bia et al. (2014) using the procedure developed by Flores et al. (2012) which in turn utilises an extension of the method employed by Dehejia and Wahba (2002). Firstly, the sample is divided in K intervals according to the distribution of treatments. For each interval, GPS is evaluated at the median level of treatment in that interval for all units. The common support region with respect to that interval is obtained by comparing the support of the distribution of GPS for the units in the interval with the individuals not in that interval. Finally, the sample is restricted to the units who are comparable across all intervals.

Another important ingredient of estimation of GPS is testing the balancing property. The balancing property refers to the characteristics of correctly specified GPS to render statistically insignificant mean difference of covariates. In PSM, the balancing of covariates is generally evaluated through comparing the mean differences of treated and comparison groups. The balancing property in the case of a continuous treatment can be tested by dividing the sample into sub-intervals and evaluating statistical significance of the differences of the mean of an interval against other intervals, which has been implemented by Hirano and Imbens (2004). Flores et al. (2012) developed a procedure utilising the likelihood ratio test, which has been implemented in this paper following the STATA routine of Bia et al. (2014) and to be discussed in due course.

After the GPS sufficiently balances covariates, the next step is the estimation of dose–response functions. Bia et al. (2014) applies Spline and Kernel techniques, implemented through utilising a partial mean approach. Specifically, they apply three methods: (i) radial spline method, (ii) penalised spline method and (iii) inverse weighting (I-W) Kernel method.

4 DATA AND DESCRIPTIVE STATISTICS

The study utilises the data of HIES of 2010 conducted by Bangladesh Bureau of Statistics. In total, 12 240 households were surveyed of which 7840 were from rural areas and 4400 from urban areas. The survey asked direct questions about the sources of remittances that

Table 2. Sources of remittances

	Urban		Rural		Total	
Modes	No.	%	No.	%	No.	%
Internal remittances	451	30	1039	70	1490	100
International remittances	344	31	762	69	1106	100

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Table 3. Summary statistics for internal remittances[1] (up to Tk 200 000)

	No. of obs.	Mean	Standard deviation	Minimum	Maximum
Internal remittances	1475	21 055.58	28 770.29	100	200 000
Net assets	1475	3946.915	105 078.9	−500 000	3 600 000
Dummy, rural–urban (rural = 1)	1475	0.699661	0.458561	0	1
Ratio of male members	1475	0.44155	0.209415	0	1
Dummy, sex of heads (female = 1)	1475	0.277966	0.448149	0	1
Age of the households' heads	1475	49.39729	15.34827	17	100
Ratio, adult to total members	1475	0.613802	0.254482	0	1
Ratio, young to total members	1475	0.294525	0.226952	0	0.857143
Dummy, religion (Islam = 1)[2]	1475	0.896271	0.305012	0	1
Dummy, any member abroad (abroad = 1)	1475	0.016949	0.129125	0	1
Dummy, higher education (1 if ≥ SSC)	1475	0.166102	0.372298	0	1
Total cultivable land	1475	58.51254	146.4447	0	2500
Per capita consumption	1474	52 584.89	35 262.04	10 015	738 469.8
Pension and gratuity	1475	1363.529	16 927.09	0	600 000
Profit and interest	1475	466.1708	4881.547	0	100 000

[1]Remittance is in Taka. 1 Taka = $0.013.
[2]The survey asked a specific question about the religion of individual members of the households. We regard the religion of the household the same as the religion of the head. For a detailed description of how the variables have been constructed using the survey data, see Chowdhury (2015).

enabled classifiying the houselhods in four categories, that is, 9524 households received 'No Remittances', 1490 received only 'Internal Remittances', 1106 households received only 'International Remittances' and 120 households received 'Both Internal and International Remittances'. The categories 'No remittances' and 'Both Internal and International Remittances' have been excluded from the subsequent analysis and are not presented in Table 2.

Table 2 presents these statistics by segregating the households in rural and urban locations. The incidence of both internal and international remittances is higher in rural households compared with the urban households.

The study treats the internal and international remittances received by households as treatments and net assets as outcomes. The net assets variable equals the purchase of land, property and other valuables minus the sale of any assets in the survey year. As not many households received internal remittances above Tk 200 000, we treat remittances above Tk 200 000 or Tk 2 Lac[1] as outliers and drop them from subsequent analysis. Table 3 presents the summery statistics of households with remittances up to Tk 200 000. The dropping of households above Tk 2 Lac resulted in only 15 households being dropped. The table shows that the average amount of internal remittances is 21 055.58 Tk and the minimum amount is 100 Tk. The distribution of remittances is right-skewed. The standard deviation of remittances is 28 770.29. Table 3 presents other variables utilised in the construction of GPS. Table 2 shows that most households (70 per cent) are located in rural areas. About half of the members of the households are male. About 29 per cent households have female

[1]1 Lac = 100 000. Lac is a common denominator used in the Indian subcontinent. Another commonly used denominator is Crore, 1 Crore = 10 000 000.

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heads, while the average age of the household head is 49 years. On average, households are composed of 60 per cent adults (age between 15 and 65) and 30 per cent young (age below 15). The dominant religion is Islam as 90 per cent households are Muslims. These statistics indicate that the sampling is representative of the total population of Bangladesh. However, only a very small number of households have a member that lived abroad (around 1.7 per cent). Finally, about 17 per cent households have at least one member with education higher than Secondary School Certificate (SSC). Table 2 also shows that a handful of households reported to have cultivable land, received pension, gratuity, profit and interest. Another important variable is per capita consumption. Although it varies substantially, the mean of remittances is about 40 per cent of the average per capita consumption. It shows that remittances play a substantial role in the average household expenditure. Note also that the average of the net assets is 3946.915, which is about five times smaller than the average remittances.

Table 4 represents the summary statistics of international remittances for international remittances up to Tk 200 000 to allow some form of comparability with Table 3. Table 4 shows that the minimum amount of international remittances is 4. Although the minimum looks very low, the average of international remittances is Tk 90 623.91 which is about six times higher than the average internal remittances in Table 2. Comparing between the net assets from Tables 3 and 4, we see that it is about 2.5 times higher in Table 4. However, the net assets is 10 times smaller than the average international remittances in Table 4. Interestingly, about 44 per cent households receiving remittances has a female as the head of the household. On Table 4, we also see that more households reported to have members abroad although it is still only about 4 per cent. The per capita consumption figures in Table 4 are interestingly almost the same as the one in Table 3.

In the tables, we presented summary statistics for households with remittances up to Tk 2 Lac. For the estimation of GPS, we utilised, as well, other intervals of remittances such as

Table 4. Summary statistics for international remittances (up to Tk 200 000)

	No. of obs.	Mean	Standard deviation	Minimum	Maximum
International remittances	933	90 623.91	55 633.44	4	200 000
Net assets	933	7573.312	75 822.99	−370 000	1 300 000
Dummy, rural–urban (rural = 1)	933	0.697749	0.45948	0	1
Ratio of male members	933	0.424249	0.205127	0	1
Dummy, sex of heads (female = 1)	933	0.445874	0.497328	0	1
Age of the households' heads	933	47.69668	15.89643	11	122
Ratio, adult to total members	933	0.590749	0.238809	0	1
Ratio, young to total members	933	0.348535	0.239533	0	0.833333
Dummy, religion (Islam = 1)	933	0.950697	0.216617	0	1
Dummy, any member abroad (abroad = 1)	933	0.046088	0.209788	0	1
Dummy, higher education (1 if ≥ SSC)	933	0.170418	0.376201	0	1
Total cultivable land	933	71.10289	143.2392	0	2000
Per capita consumption	931	61 886.23	39 025.97	6839.977	538 224
Pension and gratuity	933	1122.444	11 955.52	0	300 000
Profit and interest	933	217.5991	4139.5	0	120 000

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between Tk 25 000 to Tk 2 Lac for both internal and international remittances and up to Tk 8 Lac for international remittances. We skipped presentation of all the summary statistics for the sake of brevity.

5 ESTIMATION OF GENERALISED PROPENSITY SCORE AND DOSE–RESPONSE FUNCTIONS

This section discusses the estimation of GPS and dose–response functions. The treatment variables in our sample are internal remittances and international remittances received by households. The histograms (not reported) and summary statistics indicate that the treatment variables are not normally distributed. Therefore, the estimations of GPS and dose–response functions are conducted using a Gamma distribution.

5.1 Internal Remittances

This subsection estimates GPS and dose–response functions regarding internal remittances as treatments. It should be noted that many households received only a small amount of remittances that seems negligible compared with the asset price in Bangladesh. An analysis therefore has been conducted dropping the households that received remittances below Tk 25 000. Two households reported to have net assets above Tk 10 Lac. Those households were dropped with the truncation of the sample. The treatment variable has been divided by 1000, and the following treatment intervals have been used (0/10/25/40/60/80/100/120/140/170/200). For the sample excluding the remittances below Tk 25 000, the intervals are (25/30/40/60/80/100/120/140/160/180/200). The interval selections are arbitrary although they are aligned with the common practice of counting and perceiving monetary amounts.

The regression results for estimation of GPS are presented in the Table A1. Following Hirano and Imbens (2004), the purpose of the regression is regarded as the estimation of GPS; however, it should be also noted that a good number of covariates depict statistical significance in the results. To ensure that the individual units are comparable, all estimations are conducted after imposition of the common support condition that results in 14 observations being dropped. To test that GPS sufficiently balances the covariates, Likelihood-ratio (LR) tests have been performed following Flores et al. (2012) that has been incorporated in the STATA routine of Bia et al. (2014). The results of the tests are presented in Table 5.

The balancing test is conducted performing three regressions reported in Table 5. They are (i) restricted, which included all the covariates, (ii) unrestricted, includes both covariates and GPS terms, and lastly, (iii) GPS, which only includes the GPS terms. If GPS sufficiently balances the covariates then they should have little explanatory power conditional on the GPS. This is observed in the top panel as the restricted model that excluded the covariates cannot be rejected (p value is 0.424). On the other hand, the bottom panel shows that the restricted model that excludes GPS is clearly rejected (p value is 0). Following Flores et al. (2012) and Bia et al. (2014), we regard this as the evidence of satisfying the balancing property.

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Table 5. Balancing test for internal remittances

	Up to Tk 2 Lac	From Tk 25 000 to Tk 2 Lac
Unrestricted model: T on GPS, GPS2, GPS3 and covariates		
Restricted log likelihood	−4709.261	−1849.8909
Unrestricted log likelihood	−4702.6078	−1849.7238
Test statistics	13.306327	0.33407536
p value	0.42443834	1
Number of restrictions	13	13
Test restriction that GPS coefficients can be excluded from the unrestricted model		
Restricted log likelihood	−5761.7687	−1885.8017
Unrestricted log likelihood	−4702.6078	−1849.7238
Test statistics	2118.3219	72.155676
p value	0	0
Number of restrictions	3	3
Number of observations	1461	373

GPS, generalised propensity score.

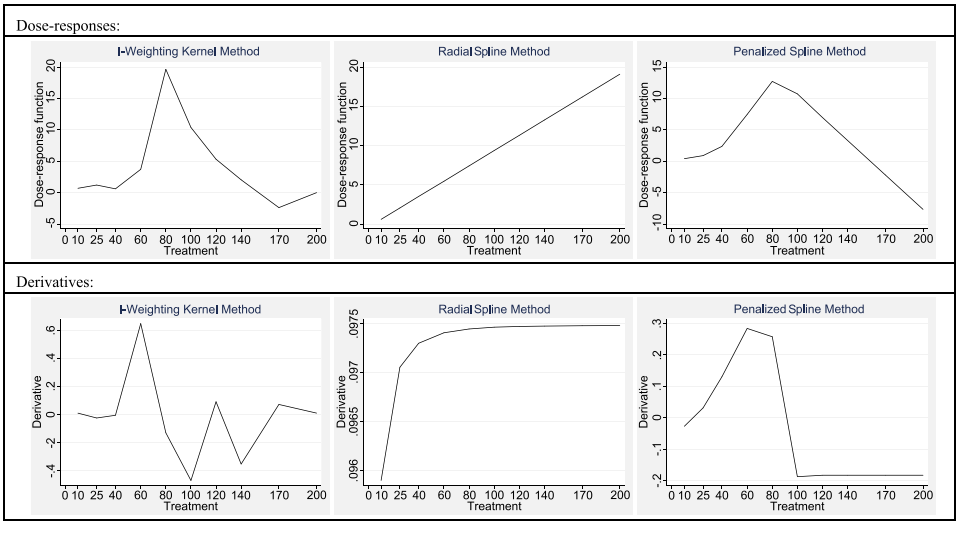

Figure 1. Internal remittances up to Tk 2 Lac: dose–responses and derivatives [Colour figure can be viewed at wileyonlinelibrary.com]

Dose–response functions are estimated using (i) radial penalised method, (ii) penalised spline method and (iii) I-W kernel method. The estimated dose–response functions and estimates treatment effects are presented Figure 1.

Figure 1 shows dose–responses and derivatives for internal remittances up to Tk 2 Lac. Essentially, we are looking for any significant patterns in the diagrams. It should be noted that the scaling of the diagrams are not equal; therefore, caution is needed for interpreting the diagrams. It is observed that both I-W kernel and penalised spline method initially demonstrated an increase in the dose–responses and derivatives and decline at a later level of treatment. Similarly, the derivatives for the two estimators register an increasing trend at

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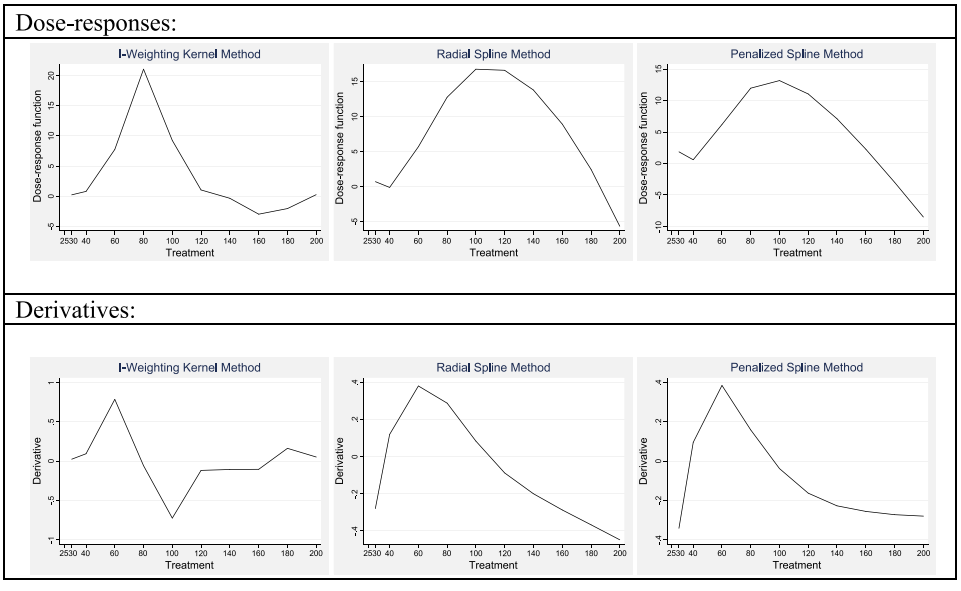

Figure 2. Internal remittances Tk 25 000 to Tk 2 Lac: dose–responses and derivatives [Colour figure can be viewed at wileyonlinelibrary.com]

the beginning, however later decline by registering negative values. The radial spline method however shows an increasing trend throughout with the derivatives later becoming almost flat.

Figure 2 shows estimated dose–responses and derivatives when the sample excludes the households with remittances less than Tk 25 000. The radial spline and penalised spline both generate similar dose–responses that show an improvement in the estimation of the dose–responses. The I-W kernel method also depicts a similar upward and later a downward trend. The derivatives of all methods produce similar diagrams with initially positive values and later going down to negative values. Comparing with what has been

Table 6. Balancing test for international remittances

	Up to Tk 2 Lac	From Tk 25 000 to Tk 2 Lac	Up to Tk 8 Lac
Unrestricted model: T on GPS, GPS2, GPS3 and covariates			
Restricted log likelihood	−4937.085	−4367.6564	−5880.31
Unrestricted log likelihood	−4932.3422	−4364.7277	−5875.82
Test statistics	9.4855048	5.8573403	8.977885
p value	0.7353674	0.95119107	0.774612
Number of restrictions	13	13	13
Test restriction that GPS coefficients can be excluded from the unrestricted model			
Restricted log likelihood	−4969.7345	−4382.4145	−6205.58
Unrestricted log likelihood	−4932.3422	−4364.7277	−5875.82
Test statistics	74.784572	35.373676	659.5187
p value	0	0	0
Number of restrictions	3	3	3
Number of observations	905	778	1065

GPS, generalised propensity score.

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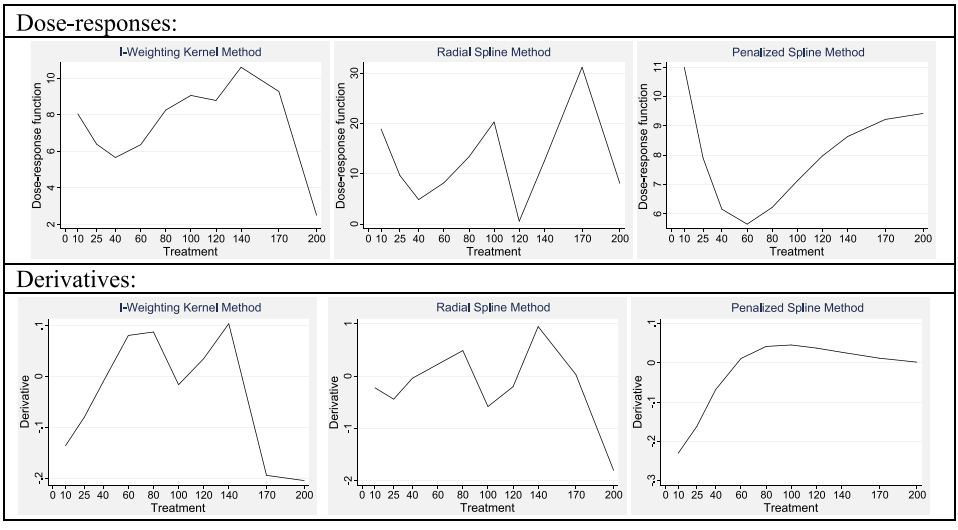

Figure 3. International remittances up to Tk 2 Lac [Colour figure can be viewed at wileyonlinelibrary.com]

observed in Figure 2, we may conclude that net assets increase at a lower level of remittances however declines as the size of internal remittances goes up.

5.2 International Remittances

A total of 1106 households reported to have received international remittances. The analysis in this section has been conducted using international remittances up to Tk 2 Lac[2] and from Tk 25 000 to Tk 2 Lac. The average size of international remittances is larger than internal remittances; we therefore have also conducted an analysis for international remittances up to Tk 8 Lac. The intervals used are similar to the ones used for the internal remittances. For the sample with international remittances up to Tk 8 Lac, the intervals are (0/25/60/100/150/200/300/400/500/600/800).

The imposition of the common support condition results in 22 observations being dropped for the sample from 0 to Tk 2 Lac. Similar numbers have been dropped in other samples. The balancing test is reported in Table 6. As before, the LR test results presented in Table 6 reveal that GPS sufficiently balances covariates. This is evident from the p values of the LR tests. As the balancing test produces satisfactory result, similar to the test report of Table 5, we proceed to the estimation of dose–responses and derivatives.

Figure 3 shows dose–responses and derivatives for international remittances up to Tk 2 Lac. The dose–responses of I-W kernel and radial spline initially show an increasing tendency and later a decreasing tendency; however, for penalised spline method, it shows the opposite tendency. When looking at the derivatives, we observe close to inverted U-shaped patterns with initially upward sloping and later downward sloping trends.

[2]We encountered some issues in running the program while calculating the standard errors for I-W Kernel estimator in the case of international remittances up to Tk 2 Lac. Other estimations encountered no issues. All estimations produced diagrams as required.

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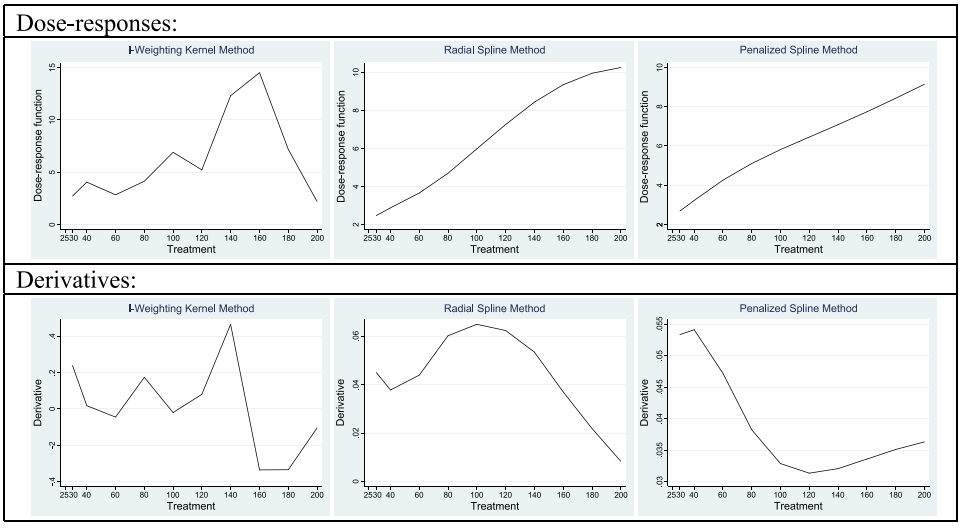

Figure 4. International remittances from Tk 25 000 to Tk 2 Lac [Colour figure can be viewed at wileyonlinelibrary.com]

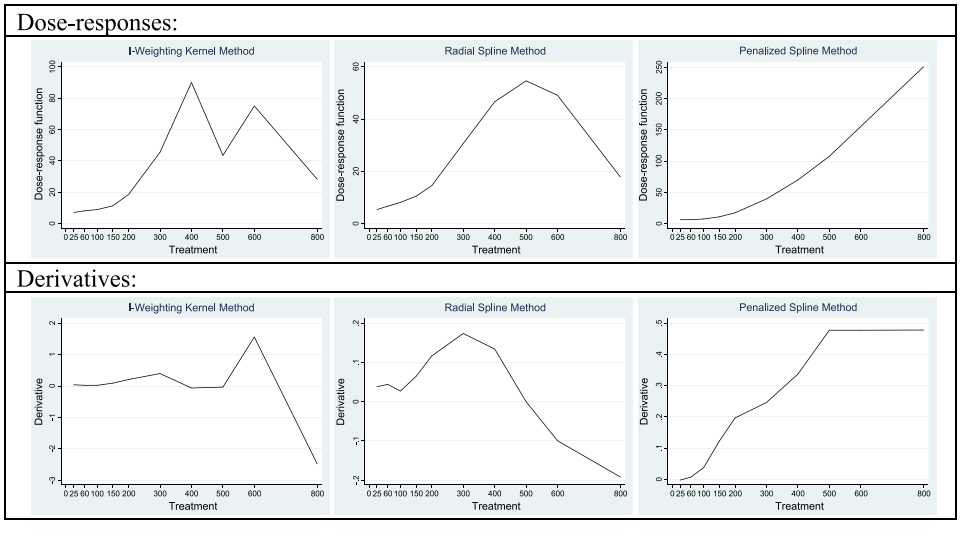

Figure 5. International remittances to Tk 8 Lac [Colour figure can be viewed at wileyonlinelibrary.com]

Figure 4 estimates dose–responses and derivatives for the households who received remittances between Tk 25 000 to Tk 2 Lac. The dose–response of I-W kernel is similar to the one in Figure 3; however, for radial and penalised spline, they are increasing. The derivatives show mixed tendency, although they tend to be positive except for the I-W kernel estimator. It is interesting to note that the diagrams of Figures 3 and 4 look similar to the diagrams obtained for internal remittances in Figures 1 and 2. It therefore suggests that internal and international remittances have similar impacts on net assets.

As mentioned earlier, international remittances are larger on average; therefore, we furthered this analysis by estimating dose–responses and derivatives for international

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remittances up to Tk 8 Lac. Figure 5 presents the relevant diagrams. Dose–responses of I-W kernel and radial spline show initially an increasing and later a decreasing graph. For penalised spline, it is throughout increasing. The derivatives of I-W kernel and radial spline on the other hand become negative as the size of remittances increase.

The results of this section are mixed, although can be summarised as follows. For a lower level of remittances, we observe that the net assets go up; however, when the level is high, we do not observe similar impact rather observe a decreasing tendency. The results show that internal and international remittances have some similarities in utilisation and a higher level of remittances may result in a decrease of assets.

6 PARAMETRIC ESTIMATION OF GENERALISED PROPENSITY SCORE AND DOSE–RESPONSE FUNCTIONS

The estimation of dose–response functions in the previous section utilised a non-parametric approach, which is different from the parametric approach used by Hirano and Imbens (2004). To investigate further, in the succeeding text, we employ a parametric method of estimation following the STATA routine of Guardabascio and Ventura (2014). The STATA routine developed by Guardabascio and Ventura (2014) closely follows the approach adopted by Hirano and Imbens (2004) and Bia and Mattei (2008). The implementation is conducted in following steps:

Step 1: Estimate GPS using a generalised linear model, as in Bia et al. (2014).

Step 2: Balancing property is checked by utilising the blocking on GPS approach developed by Hirano and Imbens (2004). Potential treatment values are divided in K intervals, and GPS is estimated at user specified representative points (e.g. mean of each interval) for each units. Within each treatment interval, estimated GPS is divided in m intervals. Within the same GPS interval, the mean differences of covariates are tested for the unit that belongs to the same treatment interval with the mean difference of the covariate for the units that belong to other treatment intervals. Then the mean differences weighted by the number of observations in each GPS group are combined. The balancing property is satisfied if the mean differences of covariates are insignificant that is demonstrated through t-tests.

Step 3: Estimating the conditional expectation of outcomes given the treatment and GPS using a parametric regression function, that is,

$$Y_i = \beta_0 + \beta_1 T_i + \beta_2 T_i^2 + \beta_3 GPS_i + \beta_4 GPS_i^2 + \beta_5 T_i GPS_i$$

Step 4: Estimate the dose–response function by averaging over the conditional output for each level of treatments.

$$E\left[\widehat{Y(t)}\right] = \frac{1}{N}\sum_{i=1}^{N} \widehat{\beta}_0 + \widehat{\beta}_1 t + \widehat{\beta}_2 t^2 + \widehat{\beta}_3 \widehat{r}(t, X_i) + \widehat{\beta}_4 \widehat{r}(t, X_i)^2 + \widehat{\beta}_5 t\widehat{r}(t, X_i)$$

We present the diagrams of estimated GPS and dose–response functions in Figures 6 and 7.

As can be observed from Figures 6 and 7, the estimated dose–responses and derivatives obtained in the non-parametric approach are to some extent replicated in the parametric approach. We observe that the derivatives for the internal remittances from Tk 25 000 to Tk 2 Lac are mostly negative implying a decrease in assets with the increase of

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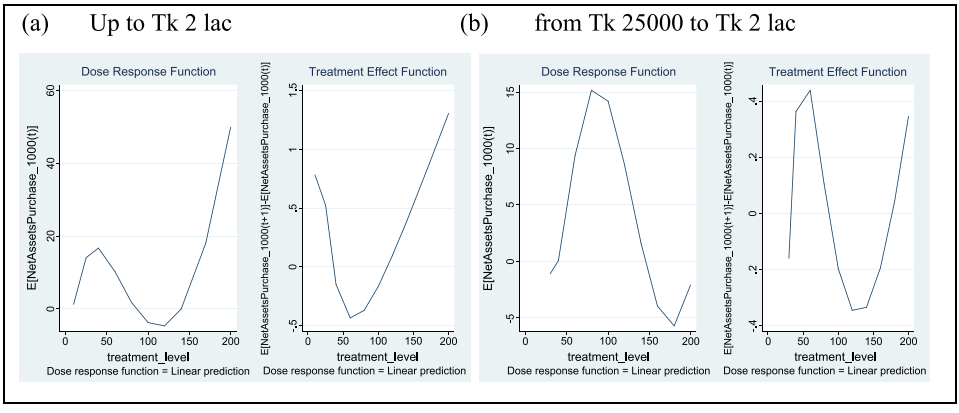

Figure 6. Dose–response functions and derivatives for internal remittances [Colour figure can be viewed at wileyonlinelibrary.com]

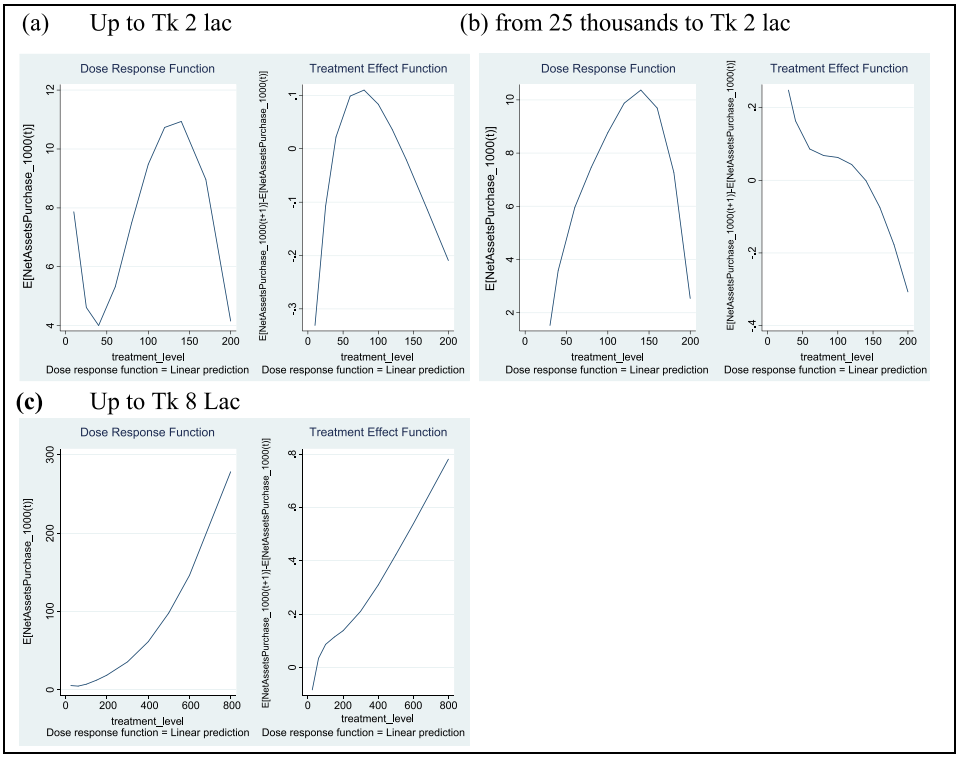

Figure 7. Dose–response functions and derivatives for international remittances [Colour figure can be viewed at wileyonlinelibrary.com]

remittances. For international remittances, the dose–responses and derivatives demonstrate similar tendencies for the remittances up to Tk 2 Lac. However, for international remittances up to Tk 8 Lac, the dose–responses and derivatives show an increasing trend. This specific result is dissimilar to the one obtained using the non-parametric approach.

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7 DISCUSSION AND CONCLUSION

In Sections 5 and 6, we have analysed how remittances affect net assets in Bangladesh. The idea of fungibility of remittances implies that households should treat remittances like any other sources of income, and there should be no impact of the source of remittances on the use of remittances. However, in Bangladesh, it is in general believed that international remittances are largely used for asset accumulation. From the diagrams of dose–responses and derivatives obtained in various sections, it can be interpreted that with a lower level of internal remittances households increase the purchase of assets, however at a higher level of internal remittances net assets fall.

For the international remittances, we observe that similar to the internal remittances, the derivatives tend to start from positive values and then become negative. An inverted U-shaped tendency is evident. A similar pattern is also observed in the parametric estimation of derivatives, with the exception of when remittances are up to Tk 8 Lac. Therefore, the results do not allow us to infer that the international remittances are used for asset accumulation, and if any, it shows a decline of asset accumulation with increased remittances. This finding is aligned with the findings of some other previous studies. Ahmed et al. (2018b) for Pakistan found that productive assets that constitute non-agricultural land registered insignificant changes with the increase of foreign remittances. Garip (2014) did not use the non-agricultural land in classifying assets, however observed a decline in asset holding with foreign remittances for rich households in Thailand. Quisumbing and McNiven (2010) found that in the Philippines, internal remittances do not positively affect land assets. Fransen and Mazzucato (2014) found evidence of only weak effects on asset ownership.

In terms of fungibility, De and Ratha (2012) found that international remittances are not fungible as they are targeted better, and senders closely monitor the uses. Our finding however is contrasting with De and Ratha (2012). The diagrams for dose–responses and derivatives in our paper do not demonstrate a clear difference between internal and international remittances. This similarity in the use of internal and international remittances has been observed by some other studies. Nguyen and Nguyen (2015) in a study that looked at the effects of internal and international remittances in Vietnam found 2 per cent increase in the school completion rate for the households with international remittances, but, in other cases, such as school enrolment or health care, observed no difference of effects. Ahmed et al. (2018a) found that both internal and international remittances impact on higher human capital accumulation, hence pointing to similar effects by the source of remittances. Cox-Edwards and Rodríguez-Oreggia (2009) found no systematic differences in labour force behaviour associated to remittances in Maxico. Acosta (2011) found evidence of a strong reduction of child wage labour in remittance-recipient households however a null or insignificant overall impact of remittances on schooling. Adams (1998) noted in Pakistan that the international remittances impact positively in land asset accumulation because the size of remittances is larger. Therefore, what emerges suggests that it is not just the source but the size also determine the effect. Tables 3 and 4 depict that international remittances are on average larger that internal remittances. In the parametric study, when we considered remittances up to Tk 8 Lac, the diagram demonstrated positive effect. Hence, the size of remittances is likely to influence the uses to which they are put within the household.

It can be stated here that remittances are regarded as private transfers arising because of incomplete contracts between senders and receivers. Torero and Viceisza (2015) conducting an experiment, identified that migrants prefer how receivers spend remittances. Therefore, the motivation of remittances is important as well as the interest/cost of the

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sender to monitor the use of remittances. Rapoport and Docquier (2006) identified inheritance as an important motivation for remittances. When assets are tangible, the remitters have direct interest in ensuring the use of remittances for asset acquisition. However, assets/wealth acquisition requires a larger amount of remittances, relative to other motivations of remittances, such as altruism. Additionally, tangible assets require a significant endeavour for maintenance and monitoring. If a mechanism for that is absent, a household may not invest by accumulating assets.

The aforementioned paragraph therefore points to one of the limitations of our study, that is, the presence of household level unobservables, such as motivations, and the capacity to monitor and maintain. Although the HIES provides a substantial amount of household level data, it surely misses many variables that influence the utilisation of remittances. While GPS sufficiently balanced the households in our analysis, the constructed GPS could not take unobservables into consideration; hence, the validity of the unconfoundedness assumption can be still questioned.

Our paper does not look at different components of assets such as whether remittances are used for acquisition of lands or property or to buy valuable assets and to do so would be a significant extension of the current analysis. We aim to do it in a separate paper as the current paper is already dense in tables and diagrams. Finally, it is important to note that households usually maintain a portfolio of assets and accordingly acquire different types of assets. Therefore, just looking at one or two types of assets may not deliver a proper understanding of assets acquisition behaviour of households. Nevertheless, this paper provides important understanding on households' utilisation of remittances. The impact of remittances in Asian countries is relatively understudied. Although we only worked with Bangladesh, it can be easily replicated for other countries of Asia subject to the availability of data. Additionally, it looks at internal remittances that only recently getting the due attention. We expect that therefore this paper will attract significant academic and policy level interest in the near future.

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APPENDIX A. REGRESSION RESULTS FOR THE ESTIMATION OF GPS

Table A1. Estimation of generalised propensity score for internal remittances

Covariates	Internal remittances (up to Tk 2 Lac)	Internal remittances (from Tk 25 000 to Tk 2 Lac)
Dummy, rural–urban (rural = 1)	0.152792 (0.082702)*	−0.048659 (0.069641)
Ratio of male members	0.159129 (0.195404)	0.013909 (0.159171)
Dummy, sex of heads (female = 1)	0.639745 (0.092930)***	0.049263 (0.074495)
Age of the households' heads	0.015234 (0.002897)***	0.001336 (0.002480)
Ratio, adult to total members	0.688828 (0.206197)***	0.326155 (0.188437)*
Ratio, young to total members	1.370025 (0.252483)***	0.675857 (0.233162)***
Dummy, religion (Islam = 1)[a]	0.074484 (0.114791)	0.07598910 (0.096991)
Dummy, any member abroad (abroad = 1)	0.566699 (0.270161)**	0.170753 (0.189098)
Dummy, higher education (1 if ≥ SSC)	0.417707 (0.102229)***	0.025184 (0.074362)
Total cultivable land	0.000104 (0.000273)	0.000015 (0.000186)
Per capita consumption	0.00000912 (0.000001)***	0.000004 (0.000001)***
Pension and gratuity	−0.0000010 (0.000002)	0.000002 (0.000004)
Profit and interest	−0.0000023 (0.000006)	0.000002 (0.000005)
Constant	0.3862972 (0.328755)	3.276493 (0.308832)***
Number of observations	1474	379

[a]The survey asked a specific question about the religion of individual members of the households. We regard the religion of the household the same as the religion of the head. For a detailed description of how the variables have been constructed using the survey data, see Chowdhury (2015).

***$p < 0.01$.

**$p < 0.05$.

*$p < 0.10$.

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Table A2. Estimation of generalised propensity score for international remittances

Covariates	Up to Tk 2 Lac	From Tk 25 000 to Tk 2 Lac	Up to Tk 8 Lac
Dummy, rural–urban (rural = 1)	−0.035306 (0.047321)	−0.022498 (0.037946)	−0.023454 (0.064509)
Ratio of male members	−0.005966 (0.113224)	−0.037863 (0.090362)	0.126729 (0.152929)
Dummy, sex of heads (female = 1)	0.304874 (0.057898)***	0.110572 (0.046753)**	0.315675 (0.075726)***
Age of the households' heads	0.003708 (0.001785)**	0.001094 (0.001446)	0.006756 (0.002305)***
Ratio, adult to total members	0.348956 (0.165847)**	0.321747 (0.133470)**	0.680719 (0.235363)***
Ratio, young to total members	0.312325 (0.182233)*	0.290472 (0.146930)**	0.666699 (0.254787)***
Dummy, religion (Islam = 1)[a]	0.153186 (0.095223)	0.147222 (0.077308)*	0.272950 (0.135237)**
Dummy, any member abroad (abroad = 1)	0.251467 (0.099348)**	0.185966 (0.078250)**	0.287461 (0.129197)**
Dummy, higher education (1 if ≥ SSC)	−0.028061 (0.057214)	−0.011889 (0.046363)	0.071745 (0.075531)*
Total cultivable land	0.000012 (0.000164)	−0.000023 (0.000135)	0.000331 (0.000192)
Per capita consumption	0.000002 (0.000001)***	0.000002 (0.0000005)***	0.000004 (0.000001)***
Pension and gratuity	0.000001 (0.000002)	0.0000001 (0.000002)	−0.000003 (0.000003)
Profit and interest	−0.000003 (0.000005)	−0.000004 (0.000004)	0.000004 (0.000007)
Constant	3.584634 (0.241822)***	4.011844 (0.194386)***	3.144426 (0.329031)***
Number of observations	931	799	1093

[a]The survey asked a specific question about the religion of individual members of the households. We regard the religion of the household the same as the religion of the head. For a detailed description of how the variables have been constructed using the survey data, see Chowdhury (2015).

***$p < 0.01$.

**$p < 0.05$.

*$p < 0.10$.

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